THE TECH

SPECIAL CHEMISTRY AND CHEMICAL ENGINEERING ISSUE

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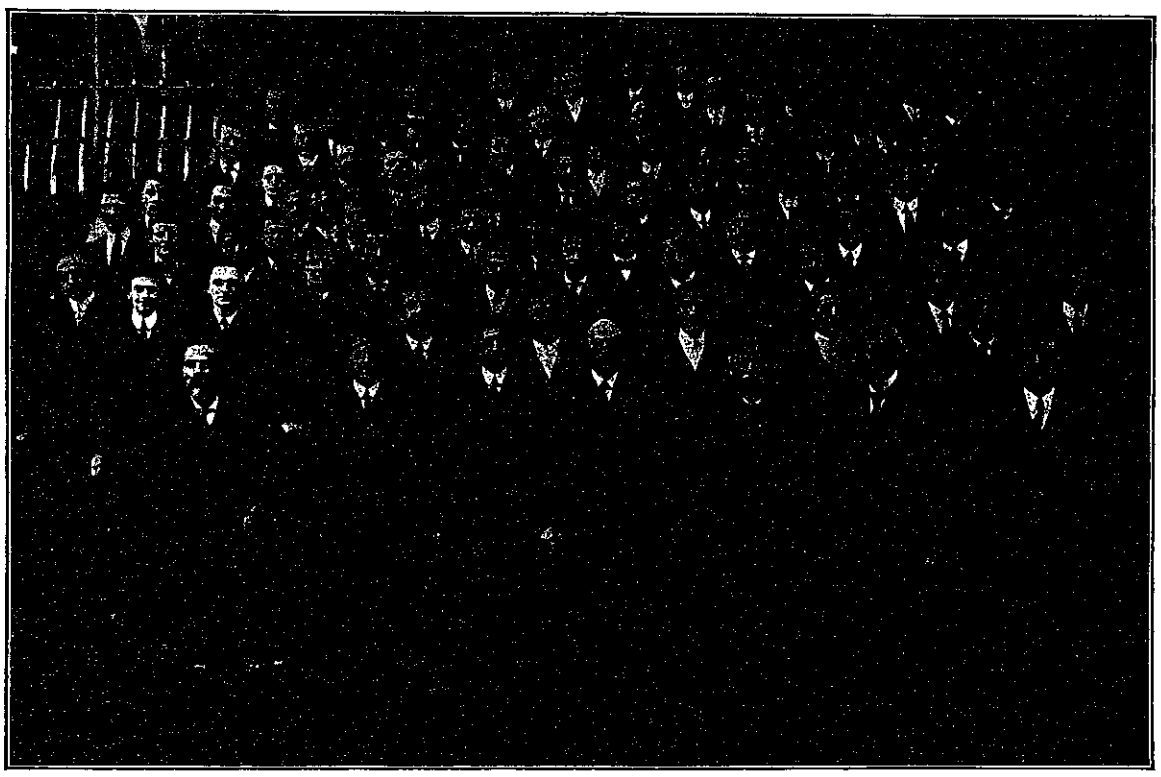

INSTRUCTORS AND MEMBERS OF COURSES V. AND X.

FEW INDUSTRIES NOT FOUNDED ON CHEMISTRY

Manufacturing Processes Advance With Knowledge Of Its Principles

By W. H. WALKER.

The art of tanning, of dyeing, of brewing, and of the other industries which depend for success upon a change in the composition of the material acted upon, preceded by many years the discovery of the principle of science upon which these arts in reality rested. Our forefathers could brew good beer long before they could distinguish a saccharomyces cerevisiae from a bacillus pastorianis; our mothers could dye yarns and color cloth before they were familiar with the diazoamido-quinazolines. To tan leather it is not necessary to know that an animal hide is a colloidal membrane susceptible to changes in osmotic pressure. But so long as these industries depended for their success upon rule of thumb method, failure was common, costs were high, and progress was exceedingly slow. It was only as the chemical principles which underly the processes involved in an industry were determined and appreciated did the product improve in quality, the cost decrease, and the industry grow.

There are relatively few industries upon which we are dependent for the necessities, or indeed comfort of life, that are not founded upon chemical change. But the mechanical appliances or apparatus by which chemical reaction may be carried on, are not infrequently the controlling factors in determining whether a given chemical process will be a commercial or practical success or not. Thus the chemical reactions involved in the Solvay Soda Process were well understood many years before the plant in which the process could be economically carried on was designed and constructed.

Hence the two points of view from which a course in industrial chemistry or, as the subject may more appropri-

(Continued on page 45.)

CHEMISTRY ONE OF SIX COURSES FIRST GIVEN AT INSTITUTE

Charles W. Eliot, Afterwards President Of Harvard And F. H. Storer Were First Professors

By HENRY P. TALBOT.

The first catalogue of the Institute for 1865-66, describes six professional courses, of which one is a "Course in Practical Chemistry." The subjects of the first two years of all of these courses were identical, and are of interest both by comparison and contrast with the subjects of the Course in Chemistry as offered at present. They were: Algebra, Plane and Spherical Trigonometry, Solid Geometry, Mechanical and Freehand Drawing, Elementary Mechanics (later called Physics), Chemistry, English Language and Literature and French in the first year, and Coordinate Analytical Geometry, Calculus, Navigation and Nautical Astronomy, Surveying, Descriptive Geometry, Experimental Physics, German, Qualitative Analysis and English in the second year. In the third and fourth years of the Course in Practical Chemistry three groups of studies were offered: Industrial Chemistry, Metallurgy, and General Studies, the last including such subjects as French, German, History, Political Economy, Science of Government, Mental and Moral Philosophy, Logic, Rhetoric, English Literature, Zoology, Physiology, and Botany. Quantitative Analysis and Drawing were included in both of the first two groups and considerable Mineralogy in the first and Geology in the second. Organic Chemistry and additional Physics were soon introduced and these constituted the subjects of the Course with minor modifications for a considerable number of years and, indeed, may be said to be still the foundation of the Courses in Chemistry and Chemical Engineering as they exist today. It is interesting to note that until 1871 graduates were expected to pass a degree examination, which could be oral, written or in the laboratory, on all subjects taken during the entire course. Until 1872 the degree awarded for all courses was "Graduate of the Institute in——," the degree Bachelor of Science having been first used in that year.

In 1865 the Department was numerically small but potentially important. It comprised Charles W. Eliot, who was Professor of General and Industrial Chemistry, and Frank H. Storer, Professor of Analytical Chemistry and Metallurgy, the first now so widely known for his educational work in the presidency of Harvard, to which he went from the Institute in 1869, and the second recognized as an authoritative writer on agricultural chemistry. The methods pursued by these men were also significant, for the Institute was among the first to insist upon the importance of laboratory methods of instruction which, in the terms of the original catalogue, "trains the senses to observe with accuracy, and the judgment to rely with confidence on the proof of actual experiment." The Department occupied five rooms in the basement of the Rogers Building for a number of years, to which other rooms were gradually added until in 1883 the Department was transferred to the present Walker Building. These quarters have, in turn, been outgrown until the Department occupies about forty-five rooms, located in four different buildings and accommodating nearly or quite a thousand students.

The development of the Department may be most concisely stated by noting the men who have mainly contributed to its growth. In 1866 Cyrus M. Warren, the founder of the Warren Funds for Chemical Research, became Professor of Organic Chemistry and remained such until 1871. In 1868 John M. Ordway brought to the Department

(Continued on page 48.)

"THEORETICAL" MEANS PRACTICAL CHEMISTRY

Deals With Laws And Principles Rather Than Separate Facts

By A. A. NOYES

The name theoretical chemistry has come to be employed to designate that part of chemistry which deals with the generalizations of the science,—with the laws and principles which have been found to sum up or express a large number of chemical phenomena. The term theoretical is therefor used in the scientific sense, to signify a correlated body of knowledge, and not at all in the colloquial sense, in which theoretical is often contrasted with practical and is made to imply a conclusion reached by mental processes rather than one based on experience. In so far as the progress of the science has enabled the facts of chemistry to be expressed by generalized statements or principles, it is evidently far simpler and more practical to study those principles than to attempt to learn one by one the vast number of isolated facts from which they have been derived. "Theoretical" chemistry is therefore to be considered a most practical part of the education of the technical chemist, especially in view of its great development within recent years in directions that are of direct application in chemical industries.

It will be seen, however, from this statement, that theoretical chemistry is not properly to be regarded as a separate branch of the science. The principles with which it deals are the fundamental ones underlying all branches of chemistry. Accordingly, throughout all the chemical subjects, beginning with the inorganic chemistry of the first year and continuing through the qualitative and quantitative analysis, the organic chemistry, and industrial chemistry of the higher years, much emphasis is laid on

(Continued on page 44.)

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BOSTON, MASS., FEBRUARY 26, 1910.

TABLE OF CONTENTS.

CALENDAR.

Saturday, Feb. 26.

3:00—Indoor Track Meet, 1912 vs. 1913, at Gym.
7:30—Mining Engineering Society, Union. Illustrated Lecture by Prof. Daly on "Hawaiian Volcanoes."
8:00—Basket-ball. Tech vs. Maine at Gym.
8:00—Gym Meet. Tech vs. Amherst at Gym.

Monday, Feb. 28.

1 P. M.—1911 Class Meeting in 6 Lowell
1 P. M.—1913 Class Meeting in H. H.

GENERAL NEWS

TELEGRAPH NEWS OF THE MORNING.

WEATHER REPORT.

Washington, Feb. 26.—Fair and warmer today, with light variable winds.

Boston, Feb. 26.—George W. Coleman, the Cambridge bank defaulter, was captured yesterday morning at the Trinity Place Station of the Boston & Albany railroad. When Coleman arrived on the Chicago train he was met by friends and hurried into a cab. Deputy Marshal Bancroft stopped the cab however, before it had gone far. and after some trouble Coleman was driven off to the Charles Street jail, where he was confined by default of $50,000 bail.

Philadelphia, Feb. 26.—Encouraged by the success that met its efforts to run its cars yesterday and last night, the Rapid Transit Company began today to open up the additional lines, which have been tied up since the beginning of the strike. The Company will consider the matter of arbitration which was proposed by the clergymen at a special meeting of the board of directors.

Boston, Feb. 26.—The photo-speed-recorder, an instrument devised last spring by two Technology scientists, Dr. Herbert T. Kalmus and Dr. Daniel F. Comstock, for the automatic recording of the velocity of automobiles in traffic regulation, has been officially recognized by the state by the decision of the full bench of the supreme court in the case of the commonwealth vs. William S. Buxton of Allston, who had filed exceptions in the lower courts in his case of overspeeding on the grounds that the instrument was not officially accurate. The recorder was tried by the police under the direction of the Technology scientists last April, and on the decision of the test case rested its value.

Boston, Feb. 26.—On March 3 and thereafter, all Chinese entering the United States will come through the port of Boston, arriving here from Halifax. Nine are due here on that day.

Boston, Feb. 26.—Commander Peary's eskimo dogs, which accompanied him to the North Pole, were the chief attraction at Mechanics Building last evening. Owing to th e warmth, the dogs were placed up-stairs, where the windows can be left open.

South Bethlehem, Pa., Feb. 26.—The first open violence since the strike at the Bethlehem Steel Works was inaugurated occurred yesterday morning, when a crowd of 500 foreigners endeavored to prevent the non-union men from going to work.

1910 CLASS MEETING

Seniors Agree To Support The Institute Committee

Much important business was transacted by those seniors who were present at the meeting of the class yesterday. After the reports of secretary and treasurer had been read and accepted, Pres. Goodwin stated that the Board of Directors recommended an assessment of fifty cents per man for the present term. The class voted to accept this recommendation. The Board of Directors also recommended that only those men who are taking three-fourths of their courses in the senior year and who had paid their class dues to date should be eligible for the Class Day Committee. This also was approved by the class, and Pres. Goodwin appointed the following men as an election committee: H. S. Cleverdon, F. A. Hurley, J. Avery, E. Stuart and F. Bell. This committee was instructed to prepare and post a list of all the men eligible for the class-day committee. The question as to whether the class should assume the financial responsibility of the Senior Portfolio next came up. Mr. C. C. Hield made a statement of what the Portfolio Committee deemed necessary in this matter in order that they might do their work most efficiently. The class voted unanimously to accept the responsibility for the debts incurred by the committee.

The very important matter of the amendment to the constitution proposed by the Institute Committee was passed upon after only a brief discussion. Pres. Goodwin stated that no half-way course was possible; that the Institute Committee must either receive full power or cease to exist. The same view was expressed by other members of the class and was accepted by those present, for they voted unanimously in favor of the amendment.

The nature of the Finance Committee which has been proposed was explained by Pres. Goodwin, and also the powers and responsibilities which it would have. All present seemed to be of the opinion that this committee would be a benefit to the Institute Activities, for here was practically no discussion before the Finance Committee was accepted by a unanimous vote.

Before the meeting adjourned Mr. Hield stated that all seniors positively must have their photos taken for the Portfolio before March 15, and they should also pay their deposit before this date, if they want the book.

DOUBLE-HEADER AT GYM THIS EVENING

Basketball Team Meets Maine ---Amherst vs. Tech In Gym Meet

Tonight at the Gym will be offered to the students of the Institute the best athletic attraction of the winter season. The basket-ball team meets the University of Maine in the last game of the year, and the 'varsity gym team will hold a contest with Amherst. This double-header will be well worth the attendance of every Tech man. Special inducements have been offered in the line of admission to the two, and a large crowd of spectators is expected.

Maine is sending to Boston one of its best teams in years, and a fast game is expected. Marshall, the captain and right forward, is said to be one of the best players Maine has ever had. Most of the other men are veterans of at least one year's experience. Tech will probably play with its recent change in the line-up, Parker and Crocker, backs, Johnston in center and Ell and Bennis, forwards. This change seems to have improved the work of the team and, regardless of the fact that Maine will present a strong aggregation, there will be a hard and fast contest, for the Tech team is out to win.

The dual gym meet with Amherst last year went to Amherst without much difficulty. This year Amherst will have about the same team. Shoop, last year's star, will be present, and should carry off a number of points himself; Waklee is one of Amherst's best tumblers. Technology should carry off the honors in the horizontal bars. C. F. Doble should get a first in the parallel bars and H. S. Gott should also place. In the flying ring, B. Darrow and W. D. Allen will probably place; H. S. Gott may be conceded second or third in tumbling.

The Technology entries in the different events are:

Horizontal Bars.—B. Darrow, W. D. Allen, H. S. Gott.

Horse.—H. S. Crocker, R. W. Jacoby, L. A. Bevan.

Parallel Bars.—C. F. Doble, H. S. Gott, H. S. Crocker.

Flying Rings.—B. Darrow, M. H. Judd. W. D. Allen.

Club Swinging.—W. B. Denton, C. M. Baxter.

Single Tumbling.—H. S. Gott, C. W. Wilson.

Beverly, Feb. 26.—Albert S. Hoggs, former cashier of the Beverly savings bank, who pleaded guilty to the embezzlement of $9,300 from the bank, was sentenced to not less than 3 1-2 years nor more than six years, yesterday.

WASHINGTON, D. C.

Washington, Feb. 26.—Comdr. Peary's right to be called the discoverer of the North Pole will probably be passed upon by a committee of three expert explorers, selected by the house committee on naval affairs, before congress passes legislation rewarding Mr. Peary in any way. Members of the committee will communicate with Comdr. Peary to ascertain if the three experts suggested are acceptable to him.

Washington, Feb. 26.—Dr. Harvey Wiley, the pure food specialist, speaking at a Cornell alumni dinner here declared that women have no place in the classroom; that it is now more important that they learn cooking than calculus.

Washington, Feb. 26.—Consideration of the administration bill to create a court of commerce and amend the interstate commerce laws, was concluded yesterday by the senate committee on interstate commerce, and it was ordered reported.

Washington, Feb. 26.—The expenditure of $100,000 a year in stamping out the "white slave' traffic would be money well spent, says Sec. Nagle in submitting to the house a recommendation that the total estimate for regulating immigration be increased.

SUCTION ASH CONVEYORS DESCRIBED TO SOCIETY

Mechanicals Delay Action On Institute Committee Recommendations

Suction ashes conveyors were explained to the Mechanical Engineering Society last night by Mr. William W. Ricker. Before the talk, however, the chairman, L. A. Dewey, 1910, read a circular letter received from the Institute committee requesting the society to grant them executive authority to maintain their position.

Dewey remarked that the phrase, "authority to enforce any measure which the committee may deem advisable" was very sweeping. It was decided that the letter be left in the bulletin case in Eng. A for the members to inspect. Action will be taken at a later meeting, as it is not required until March 23d.

The annual banquet of the society will be held at the Boston City Club, 9 Beacon St. on Tuesday evening, March 8 at 6.30 P. M. At this dinner the annual election of officers will be held. Nominations signed by five men must be handed in previously in order that the ballot may be printed.

The evening talk was given by Mr. William W. Ricker of the Darley Engineering Co. His subject was the "Darley Suction Ashes Conveyor."

The conveyor is designed for carrying ashes from the boilers in a power plant. The system consists of a blower, a large tank in which the ashes are collected, and the pipes leading from the boilers to the tank.

The average piping used is of steel, five-sixteenths of an inch thick, the pipe eight inches in diameter. The inside surface must be as smoth as possible and no more turns are used than are necessary.

The air is drawn through the pipes at the rate of two miles a minute. It sweeps the ashes along with it. There are plants where the ashes are raised one hundred feet vertically.

This pneumatic system has also been employed in carrying coal from the cars to the storage piles. An eight-inch system is capable of moving twenty-five tons of coal an hour.

In a plan equipped with this pneumatic conveyor one man can care for the taking out of the ashes and bringing in of the coal where ordinarily it would take five men on ashes alone.

Sometimes the pipes get clogged with ashes and the whole system is thrown out. The only time Mr. Ricker saw the pipe clog was when the foreman was making a test. He gave the shovelers some cigars, and they were so anxious to see the thing succeed that they shoveled too fast and overloaded the system.

Mr. Nagel says the enforcement of the "white slave" traffic bill, now in conference between the two houses and expected to become a law in a few days, will cost $100,000 and that the work will have to be prosecuted differently than the ordinary immigration law enforcement.

FOREIGN.

London. Feb. 26.—The first trial of strength in the new Parliament occurred at a crowded session of the House of Commons, when Austen Chamberlain's fiscal amendment was rejected by a vote of 285 to 254. Speeches were made by Arthur J. Balfour, leader of the opposition; Chancellor Lloyd-George, Walter Runciman, president of the board of education; A Bonar Law, and others, none of which, however, gave any new aspect to the fiscal controversy.

Pekin, Feb. 25.—The Chinese government has deposed the Dalai Lama as head of the Tibetan government, and in an official statement explains its action on the ground that the nominal ruler had deserted the capital, following an attempt by him to organize a general revolt.

MILITARY BALL WAS BRILLIANT FUNCTION

Uniforms Of M. I. T. And Visiting Officers Make Pretty Scene

Last night, in a beautifully decorated hall, with fine music and a generally excellent program, the Military Hop of 1910 was given by the members of the M. I. T. Cadet Corps. Beginning shortly after eight with the ceremony of presentation to matrons, and lasting until after twelve, a most enjoyable dance was held.

The hall was tastily decorated with many Technology flags and banners and with a setting of palms around the matrons. Mrs. John Bigelow, Mrs. Henry P. Talbot and Mrs. Alpha T. Easton kindly served at matrons and Professors Bigelow and Talbot were present the latter part of the evening. Capt. Easton, who is now at the head of the department of Military Science at the Institute was, of course, a guest of honor.

The grand march was lead by Major John A. Herlihy and Miss Margaret F. Lisk, followed by nearly a hundred couples, the officers of the Tech batallion coming after Major Herlihy in order of rank.

Officers were present from Lynn English, Lynn Classical, Boston English, Gloucester, Wakefield, Hyde Park and Stoneham High Schools. A number of officers from the Lynn and English Classical High Girls' Battalions were also present and made a remarkably neat appearance in their blue cloth uniforms, elaborately trimmed with gold braid. These officers proved themselves fine dancers whatever their abilities as officers may be.

A large part of the attendance at the ball was made up of Tech freshmen. As this is practically the only important social affair and dance which is available during the freshman year, it is not surprising that it should be popular with them. Many of the non-commissioned officers wore their uniforms as well as the commissioned officers and seemed quite as popular with the pretty girls as did the more striking uniforms of commissioned officers.

A matter which deserves especial mention is the work of the two privates who stood at the order arms with fixed bayonets on either side of the matrons, while the couples were being presented. It lent a very imposing dignity to the affair, and the men deserve credit for the way they played their part.

The music for the occasion was furnished by A. F. Thodes' orchestra, which rendered a fine program. Refreshments were served during intermission by the Union management.

The brilliant success of the whole affair and the smoothness with which everything was carried out was due wholly to the untiring efforts of Major Herlihy and his committees, selected from among the "non-coms." The ball, apparently will be successful financially, and if so, this will be an encouragement to the officers of future years to hold an annual military hop.

The following is a list of the officers whose work helped to make the ball a successful function:

Floor Director,
Major John A. Herlihy.
Asst. Floor Director,
Adjt. John S. Selfridge.
Aids,
Capt. Louis R. Golden.
Capt. Henry S. Tirrell.
Capt. Walter W. Lang.
Capt. Frederick H. Busby.
Lieut. Charles W. Webber.
Lieut. Leroy W. Chandler.
Lieut. Henry M. Priest.
Lieut. David J. McGrath.
Lieut. Henry W. Codding
Lieut. Ernest W. Davis.
Lieut. Jabez H. Pratt.
Lieut. Roger B. Stone.

FRESHMEN VS. SOPHOMORES INDOOR TRACK MEET

This afternoon at the Gym the freshmen and sophomores will clash in the first dual meet of this kind ever held by classes in the Institute. The class spirit is keen and close contests will be the order of the day. The freshmen have formed a track team and are thus prepared to meet the stronger class with an organized resistance.

The sopohmores have had a year's experience on the track and have several 'varsity men among their numbers. The ability of the freshmen is practically unknown, except for the results shown in last Saturday's meet; and no remarkable showing was made in any single event.

There are a number of good sprinters in both classes, and the closest competition will probably be in the dashes. The field events may go to the sophomores as the freshmen are weak at that point.

The following results have been doped out by a track man, and it will be interesting to see how near they come to the actual results.

The 25-yard dash will probably go to Dolke 1912, with Trull 1913 a close second, and Grant 1912 and Reed 1912 coming next.

The 40-yard dash is conceded to Benson 1912. The other places will go to Oettinger 1912, Thompson 1913, or Reed 1912.

Benson 1912 will probably take the half-mile also. For second and third places several men will make strong bids—the sophomores having Van Alstyne and Oettinger, and the freshmen having Sampson, Munch and Bylund.

Mile run—Van Alstyne 1912 a probable first and Ferry 1912, Cartwright 1912, and Milliken 1913 dividing the other places.

The shot put will be between Hamilton 1913 and Benbow 1912, with McLeod 1913, Bray 1912, and Cairns 1913 contesting for second place.

The pole vault is expected to go to Mangon 1912, with H. Greenleaf 1912 and Rankin 1913 taking second and third respectively.

The hurdles seem to be a unknown factor. All the places are doubtful; but the winners will probably be Grant 1912, Reed 1913, and Hamilton 1912. There will be an innovation by having high hurdles instead of low this afternoon.

Dalyrimple 1912 is sure to take an easy first in the high jump. Bylund 1913, Fallon 1913, and Cairns 1913 will probably divide the other points.

NOTICES

FRENCH COLLOQUIUM B.

This subject has been announced erroneously as coming on Thursday from 12-1. It comes on Thursday from 11-12, and recites to Professor Bigelow, in Room 31 Lowell. Students wishing to attend should see Professor Bigelow at the next exercise.

GERMAN II.

Commencing Monday, the 21st, Section 18 will recite to Dr. Kurrelmeyer in Room 30 Lowell, otherwise as heretofore; and Section 8 to Professor Vogel in Room 30 Lowell as follows:
Tuesday, 12-1.
Wednesday, 12-1.
Friday, 10-11.

ALL CLUBS.

Proofs will be left for all Clubs having inserts in Technique at the Cage. If proofs are not called for in five days the editors can not be responsible for the copy.

C. E. SOCIETY MEETING, WEDNESDAY MARCH 2, 4.15 P. M., ROOM 11 ENG. B.

Mr. H. L. Coburn, M. I. T. '98, a consulting engineer on hydraulic work will speak on the Location and Design of Hydraulic Power Houses.

LOST.

One drawing set. Finder please leave note at Cage for Althouse.

Lost bunch of keys, probably in 43 DR, Friday, Feb. 18. Return P. S. '13, Cage.

1912 BASEBALL.

Battery candidates report at the Gym Monday, Wednesday and Friday afternoons. All out. V. W. ALLEN, Mgr.

HISTORY OF CHEMISTRY.

The Lecture in the History of Chemistry will hereafter begin in 11 Eng. B. on Fridays from 9 to 10 A. M.
F. J. MOORE.

Will the person who took my coat by mistake from the Phys. Lab., Thursday afternoon, please leave it at the Cage for E. T. Wettengel.

TO LET.—Large square room, suitable for one or two young men. All conveniences. Private family. Apply to Mrs. Brown, 124 Huntington Ave.
(101-2-3-4-5.)

MEMBERS OF C. E. SOCIETY—who have not yet paid their dues should do so at once in order that their names shall be included in the list of members in Technique. No names of men whose dues are not paid will be included.

FIELD OF CHEMISTRY

(Sontinued from page 48.)

have equal rights, but without infringement of my own. This makes the pleasure of study so much greater than does the feeling that one is being fed with morsels selected for their digestibility.

The Institute graduates annually a large number of chemists. My experience has shown me that usually each of them has several good opportunities for service offered him before he has had any time on his hands after graduation. It seems to me that what the country most greatly needs and will pay for in some way, is that kind of experimental work which men of our post-graduate type have been doing in Germany for the doctor's degree. A cleaner sport than chemical research would be hard to find. It does not pay quickly enough to attract the average student at Tech, but its value is sooner or later to be realized by men who can postpone their immediate entrance into the earning class.

THEORETICAL CHEMISTRY

(Continued from page 41.)

the important principles of theoretical chemistry and on their illustration by numerous applications. In these subjects, however, the principles are necessarily considered disconnectedly, interspersed with much descriptive material, and as a rule their qualitative aspect can alone be discussed. Therefore in the third year of Course V. and the fourth year of Course X. a course specifically entitled Theoretical Chemistry is given in which the general principles of chemistry are connectedly presented and their quantitative side is developed. It is this course which it is the purpose of this article briefly to describe.

PROF. A. A. NOYES.

The course includes ninety class-room and fourteen five-hour laboratory exercises, both extending throughout the year. The class-room work consists almost wholly in the solution of problems by the student. Any principle that is to be discussed is stated and explained by the instructor and a number of problems involving it are then assigned. The solutions of these problems are handed in at the next exercise and are then worked out in the class-room by the students under the guidance of the instructor. Frequent half-hour tests consisting mainly in the solution of new problems are given. Lecture experiments are presented with the purpose of making sure that the student has a practical understanding of the conceptions and quantities involved in the laws under consideration. The laboratory course has also the same purpose in view; it is not intended to teach methods of measurement, but to give the student a concrete appreciation of the phenomena that are being discussed in the class-room.

The plan of the course is to consider only a comparatively few principles, those of the greatest importance being of course selected, and to emphasize these by numerous and varied applications. In this way a thorough knowledge of the more fundamental laws of chemistry is secured rather than a superficial acquaintance with a wider field; and (what is even more important) opportunity is afforded for a continuous training in logical thinking and for developing the power of solving scientific problems. The final examinations are almost wholly a test of the degree of this power rather than of the knowledge acquired.

The subjects most fully considered in the course are the laws relating to the following phenomena; the pressure of gases, the vapor-pressure and other properties of solutions, the electrical conductivity and ionization of substances in aqueous solution, therates and equilibria of chemical reactions taking place in gaseous mixtures, in solutions, and in systems involving also solid substances, the laws of thermodynamics, the heat produced by chemical changes, the effect of temperature upon their equilibrium, and the development of electricity and electrical energy by chemical processes.

For more advanced study and research in theoretical chemistry facilities are afforded by the Research Laboratory of Physical Chemistry, which is described in the following article.

THEORETICAL LABORATORY

By A. A. NOYES.

This Laboratory, established by the Institute in 1903, is devoted to advanced study and research in theoretical and physical chemistry. The investigations are carried on in large part by a salaried staff of research associates and assistants; but its facilities are also offered to instructors from other colleges and to advanced students who wish to engage in physico-chemical research, whether with or without reference to one of the higher degrees, Master of Science or Doctor of Philosophy. The latter degree has been conferred by the Institute in the past two years upon six candidates from this laboratory.

In addition to the complete courses in physical chemistry and electro-chemistry offered by the Institute, a number of advanced seminars are held under the direction of members of the research staff. These are supplemented by weekly conferences for the discussion of investigations in the laboratory and of current publications.

The excellent equipment of the Laboratory and the services of a skilled instrument-maker permit the study of a very wide range of experimental problems. During the past few years investigations have been carried on in almost every branch of physical chemistry and electro-chemistry, and forty-six articles describing them have already been published.

INDUSTRIAL CHEMISTRY

By F. H. THORP.

In connection with the course in Industrial Chemistry, a travelling Summer School has been held several seasons. During a period of about two weeks, in June of each alternate year, a party of students from the courses in Chemistry, Chemical Engineering and Electro-Chemistry, has visited a district where various manufacturing industries could be inspected while in operation. Attendance on these trips has been entirely voluntary, each member of the party paying his own expenses, but all sharing in the reductions of hotel and railroad rates, obtained in consequence of travelling as an organized party. In order to relieve the Institute of a part, at least, of the financial burden, it seems desirable to charge a small tuition fee, which is to some extent contingent upon the number joining the party.

The number is limited, both as to maximum and minimum; with too large a crowd, the men get in each other's way in the factory, making it difficult to clearly understand what is shown; moreover, hotel accommodations become difficult to arrange. On the other hand, it is felt that too small a number would not be a creditable showing for the Institute, with its known large classes, and would hardly justify the large amount of work necessary to arrange for these excursions. Experience has shown that from a dozen to fifteen is the most satisfactory, and more than eighteen or twenty should not be taken.

Evening conferences are held, at which the various processes and plants seen during the day are discussed by the members of the party and the professors in charge, with the purpose of clearing up obscure points, in the processes observed, and of comparing the theoretical and practical economics of manufacturing.

It is not intended nor expected to learn the private formulae nor secret methods of any manufacturer; but a general idea of the magnitude and importance of the several industries will be gained and some comprehension of the great practical differences between laboratory experiments and manufacturing as carried on in a large way. The notes prepared upon these trips may prove of much use in yielding ideas later in the student's practice, even along lines totally different from the industries visited. In any case, the actual value of this Summer School cannot be estimated in money, and no man can take a serious part in it, without deriving material benefits.

MUST ANALYZE FOOD

Importance Of This Work Grows With Increase Of Frauds

By PROF. A. G. WOODMAN.

Of the three essentials for healthful life, air, water, and food, the last named is perhaps not the least important. Air and water are of little use to the system if the food consumed cannot through their aid be absorbed and assimilated. Metabolism in the body is of doubtful value if the substances eaten irritate the tissues they should nourish. Improper and ill-balanced food may be as great a factor in lessening the resistant power of the body to encroaching disease as lack of food.

Examinations of food substances may be made in order to learn their nutritive or economical value, to fix standards of purity to which materials on the market shall conform, or to determine their freedom from falsification or adulteration. In all of these cases chemical analysis is the controlling factor.

Whether it be a question of the proper balancing of protein and carbohydrate to furnish a rational ration supplying maximum nourishment and energy, or the exposure of fraudulent claims regarding some widely advertised breakfast cereal, the food chemist renders the final decision.

The service which the food analyst renders to the public is extensive and exceptional. Claims of superior excellence, received with credence by the people, are shown to be baseless. The value of cheap foods, hitherto neglected, is pointed out, and their preparation and use exploited. Common and gross errors in diet are noted and the method by which to avoid them indicated. The greatest loss in efficiency of the human machine comes from ignorance and carelessness in disobeying the natural laws of food.

The passage of a Federal Pure Food Law has awakened the public conscience, and the food materials of the markets are, through the aid of the food analyst, being held to a strict account. With the government work, the laboratory of food analysis is in close touch, and its students and their work find an appreciative reception in the furthering o this official movement.

Food anlaysis at the Institute is given in two distinct courses, a brief elementary course, followed by a course in advanced food analysis.

In the elementary course, food analysis is undertaken from the standpoint of its educational value especially and typical methods are chosen as illustrative. The methods employed are in many respects different from those to which the student has been accustomed in his previous analytical training and the diversity of apparatus and operations has high educational value, and lends interest to the work. The laboratory work is supplemented by discussions of the leading principles of nutrition and food economy, graphically illustrated. Special attention is devoted to forms of food sophistication that are of doubtful physiological or hygienic value.

The more advanced course is planned for the training of those who wish to gain an idea of what may be expected of the food chemist in municipal or government service. To this end methods of food control as officially practiced are kept in mind and the student is in constant touch with the work of state and government laboratories. A wide range of work is considered, the student is expected to make extended studies of particular problems in adulteration and control, and to present in conference to the class authoritative reports on the results of his work.

Modern conditions in living and the sale in the markets of so much manipulated material make it necessary that a certain knowledge of the approximate composition and food value of common edible substances should be an essential of education. The special application of this branch of chemical knowledge has made rapid advances in the past few years, and with the impetus it is now receiving is bound to be an important factor in future educational growth.

ANALYTICAL CHEMISTRY

By PROF. HENRY FAY.

Analytical Chemistry is the tool by which the chemist accomplishes his work. It tells him of what a substance is composed and of how much there is of each component or element making up the whole. Chemical analysis consists of the systematic treatment of a substance or mixture with selected reagents in order to determine the singular components or elements by the phenomena accompanying this treatment. When the process is so limited as to determine the character only of the components it is spoken of as qualitative; when it is pursued in such a manner as to tell the amounts of each component in the substance or mixture it is spoken of as quantitative. The primary purpose of analytical chemistry is to tell what a particular substance is and how much there is of it, and the subject is, therefore, divided into Qualitative and Quantitative Analysis.

To satisfactorily pursue either branch of analytical chemistry one must have received a thorough training in the fundamental principles and laws of general chemistry. He must have accumulated a knowledge of the laws and properties of matter, and of the elements of mathematics, and must have been trained to reason from cause to effect, and to observe minutely the characteristic properties of the elements and their compounds.

A course in analytical chemistry is invariably begun by a thorough training in Qualitative Analysis. This is best accomplished by first studying the characteristic properties and reactions of each of the common elements, and then by a study of the reactions which are common to certain groups of elements. By reason of the latter process separations of a group of elements may be made from matter, and having separated a group, then the components of this group can be further separated into smaller groups or into compounds characteristic of the individual elements. This process not only serves to identify each component of a substance or mixture, but, if intelligently carried out, to familiarize one with the properties of the many substances worked with, and to train the senses in accurate observation. The subject is begun with a study of the simple salt containing a single metal and base, and from this one is led to mixtures of salt, and complex compounds, and finally to the analysis of minerals, alloys and the infinite variety of industrial products. The study of qualitative analysis is not only essential to the chemist, the biologist, physicist, mining, and sanitary engineer, but is also useful to the engineering profession.

Quantitative Analysis is a more strictly professional subject, although used to some extent in its simpler forms by the engineer, and logically follows the course of qualitative analysis. During the second half of the Sophomore year the student is trained in the elementary principles of gravimetric and volumetric analysis. The choice of subjects for analysis is made so as to represent the various principles involved and at the same time to emphasize the application of analysis to industry in its simpler forms. During the Junior year, the more strictly professional training is carried on, and work representing the larger commercial interests is given. In this way the analysis of iron, copper, zinc, sulphur, and other ores, the silicate rocks and other minerals is made. This is followed by a training in iron and steel analysis, the methods of which are used as types of the rapid, accurate commercial work.

In addition to the work outlined above, which is so arranged as to illustrate the various principles underlying analytical chemistry, the student receives training in the more especial branches such as organic analysis, gas and oil analysis, and the analysis of air, water and food.

The object of the course is not in any sense to train routine analysists, but to train men broadly so that they may use this knowledge as a tool in working out the larger problems of pure science or industry.

CHEMISTRY LARGE FIELD

Study Has Developed Rapidly ---Is Still Progressing

By DR. WILLIS R. WHITNEY,
Director of Research Lab. Gen. Elec. Co., Schenectady.

Not so very long ago the chemist confined his efforts to the direct transmutation of baser metals into gold. Later, the more practical and indirect methods were discovered, and still later there became evident a higher goal than gold. Parallel with this advance has been the gradual evolution of the chemist from the stage of necromancer through that of servitor to the pharmacist, and of analyser limited, to that of servant plenipotentiary. Evidently the development is still under way.

A young man considering this vocation has such a broad field before him that he may be sure of making himself useful in some, to him, interesting part of it. Within the boundaries of biological chemistry there are all the reactions of life to be studied, from parthenogenesis to immunity. Many well trained chemists will find most interesting, exciting and remunerative service in that territory in the near future. One need only to refer to the chemical work now being done in connection with such histological plagues as tuberculosis and cancer to indicate boundless utility. We may now see also the unlimited tracts of synthetic organic chemistry. It looks as though any desired physiological properties in matter could sometime be produced by the suitable study of complex organic substitution products. The architect, with his limited building materials and the relatively narrow requirements of his constructive design, must be considered cramped, in comparison with the synthetic organic chemist.

But there are many parts to the field. A thousand trained chemists in this country are now devoting their lives to the foods of animals and plants. Fully a thousand more are continually determining the composition of industrial products, to aid in keeping these materials within specifications, expressed or not, of maximum utility. Hundreds of chemists are at work in all conceivable branches of new usefulness. They are the pioneers who, possibly ahead of the instant demand, are attempting to increase the pleasure of living by new devices and inventions. I include in this group those explorers who, for the pure love of research and its otherwise unpurchasable pleasure, are advancing the science as a whole and fashioning tools for the use of later generations. We often hear of pure and applied chemistry, as though they were different kinds. It is rather the individual exponents who differ only at times.

I assume that this letter is directed to a narrow group of readers. It has a purpose. This is confined to the calling of the chemist. The aim, however poorly sighted, is at the immediate future for chemists in America. Exterpolating on the chemistry-time curve of the past, it is very evident that the rate of rise of chemistry, whether applied as an art or a science, is in both going to be very great. The demands upon the chemist are being increased more rapidly all the time.

The velocity of advance which a few years ago was greatest in Germany seems to be greatest now in America. The advanced science of chemistry or physical chemistry which in 1890 was only taught in Germany, is now taught in most of our American colleges. A few years ago a student of chemistry looked forward almost entirely to the profession of analyst, or teacher. Now he may be an engineer in any one of a score of industries, a specialist in any one of a dozen different lines of Government or municipal work, a research investigator in any one of a large number of widely different industrial laboratories, a consulting chemist, a patent specialist, an electrochemist, a metallographist, etc., etc., etc.

There are a number of research laboratories now at work in connection with manufacturing plants and others are being established. In the one of which I am the Director there are about thirty trained chemists confined to experimental work. A separate analytical laboratory at this plant employs a dozen or more chemists.

(Continued on page 48.)

CHEMISTRY IN INDUSTRIES

(Continued from page 41.)

ately be called, chemical engineering, must be constructed. First the chemical principles underlying the process and the conditions of reactions and equilibrium must be considered; and second, the design of the necessary apparatus, the choice of the materials of construction to withstand the chemical reagents employed, and the other factors which determine the final economy of the process must be fully appreciated.

The necessary supplies for every manufacturing enterprise may be considered under two heads: energy and raw materials. The raw material will differ more or less for each industry and must be considered separately; but the supply of energy is the same in all. Hence the course in industrial chemistry considers first the available sources of energy, the methods of economically using the same, whether it be as chemical, electrical, or mechanical, and the relative cost of energy in its different forms. Again many processes largely mechanical in nature are common to a number of chemical industries. In many cases the completeness of the chemical process or the perfection of the product is dependent on the preparatory mechanical treatment. Thus the chemical reaction on which the properties of Portland cement depend are largely controlled by the fineness to which the raw materials are ground and the completeness with which they are mixed. The principles of such operations as grinding and pulverizing, calcining, drying, evaporation and distillation are treated in a fundamental way without reference to any particular industry in which they may later be employed.

In considering the various manufacturing industries which depend essentially on chemical reaction, attention is given to the factors already mentioned, namely the chemistry involved, the plant necessary and the supplies called for. But of great interest and importance also is a consideration of the influence which important advances in industrial chemistry have had on civilization as a whole. The invention of gun powder revolutionized the history of the world and gave a serf with a gun an advantage over a knight in armor on horseback. Modern high explosives make it possible to remove mountains without the abnormal expenditure of faith called for by holy writ. The wonderful influence which chemistry has had upon history has been through its application to every-day life of the people, and this has been through industrial chemistry. A consideration of these broader phases should not be omitted.

The transition from a chemical preparation carried on in a laboratory to the same preparation as made on a commercial manufacturing basis, is often beset with difficulties. In order to determine some of the more important factors which must be considered in passing from a laboratory to a factory, a laboratory course in industrial chemistry has been provided. In this course no atempt is made to ape factory methods, or to do anything on a factory scale; but rather the time is devoted to the solution on a laboratory scale of that class of problems which are incident to factory work. In other words, the course attempts to teach method in attacking the problems which are inherent in factory practice from a broad chemical engineering point of view. Much attention is paid to the preparation of technical reports; in putting into concise, readable English the results of experimental work, so that the important facts may be brought before the busy man in a form that will insure his continued reading, rather than be laid aside for the leisure moment which never comes.

PROF. W. H. WALKER.

ORGANIC CHEMISTRY

Carbon Is the Most Important Element in This Study

By F. J. MOORE.

It is a matter of regret to every organic chemist that the subject of his chief interest should be so often regarded by the layman as something of great difficulty and complexity. This is perhaps due in part to the magnitude of the formulæ with which he is accustomed to fill his publications. Possibly, too, the fact that the study of Organic Chemistry is, for no very adequate reason, begun so late in most courses on Chemistry, leads the student to assume that it must offer special difficulties. The truth of the matter is rather the reverse of this apparently general impression.

Organic Chemistry is devoted to the study of a single element—carbon. On account of the regularities which govern the properties of the many compounds of this element, the subject has been most consistently and logically developed, and it is therefore characterized by a unity and consequent facility of apprehensions hardly attained in any other equally extensive department of science. For its forbidding formulæ, too, the organic chemist feels no wish to apologize, for even the beginner soon learns that these have a helpfulness and simplicity nearly proportional to their length.

It is probable that almost every one who begins the study of Chemistry originally expects to acquire therefrom information concerning the substances most frequently met with in the operations of daily life. Inorganic Chemistry, however, with which the student first enters upon the subject, soon offers him such a wealth of fascinating information concerning chlorine and phosphorus, fluorine and argon, and a hundred other substances of which he had never before heard, that he unconsciously loses his curiosity concerning the food which he eats, the clothes which he wears, the flesh which covers his bones, and the many articles like paper, wood or india-rubber with which he daily comes in contact. These all get classified in his mind under the miscellaneous heading, "organic matter"—a term even more heterogeneous in its significance than the much-abused "basic salt."

Now it is concerning things of the kind just mentioned that Organic Chemistry even now can give much information of wonderful accuracy and completeness. In some cases, of course, only a beginning has been made; but there is no doubt that, in the immediate future, there will be a rapid advance toward the solution of problems as complicated as those involved in the transformations going on in the living tissues. For this reason—that Organic Chemistry has so much to tell us concerning the details of daily life—it might well have a more conspicuous position in the curricula of our colleges than it has hitherto enjoyed. The mental training which the subject affords is also of no mean order, for few studies impart more successfully the power of reasoning by analogy.

For those who approach the study of Chemistry with the professional point of view, and in the desire to make their scientific training of use in the pursuit of a livelihood, it should be pointed out that a great number of industries have to do with the handling and transforming of organic substances and, in consequence, require for their development the services of men well trained in Organic Chemistry. These industries include the manufacture of drugs and colors, that of soap and candles, tanning, dyeing, and the textile industries, the manufacture of explosives, the refining of sugar and of oil, the distillation of spirits, the preparation and analysis of food products, and many more.

It should be conceded at once that several of the above, like tanning, soap-making, and the distillation of spirits, have, until comparatively recently, in this country, developed along empirical lines, and have been conducted, with a fair measure of success, by men trained very superficially if at all in Organic Chemistry or any other branch of the subject. These conditions are, however, rapidly passing away never to return. The necessity of conserving resources, of which we now hear so much, means an increasing scarcity of raw materials, and this, together with the increasing pressure of international competition, is forcing the manufacturers to introduce intensive methods of production, and these, in turn, are only possible under a regime controlled by scientific knowledge and trained ingenuity.

What can be accomplished by these agencies' is best illustrated by the familiar example of the coal-tar industry in Germany, where the strict application of scientific principles and technical knowledge transformed what was once the most useless and obnoxious of by-products into a veritable treasury of colors, remedies, and perfumes. This industry did not stop with the utilization of a by-product, but expanded in all directions until, in a sense, it changed the face of nature; for it modified the agricultural policy of vast areas when it substituted coal-tar alizarin for the extract from the madder-root, and drove a large portion of the natural indigo from the markets of the world, to place there the cheaper and purer product synthesized from napth alene.

Results like this were attained by combining the extraordinary foresight of the German manufacturer with the eminent research-ability of the university-trained scientist. As a consequence, theoretical scientific training has come to its full honor in German industrial life, and the laboratories of the great factories vie with those of the universities in the high quality of their scientific researches, while they surpass them in their equipment, and in the mechanical facilities for investigation which they afford.

That similar t_ansformations are soon to be brought about in the industries of this country no one can doubt. Research Laboratories are already springing up in connection with the operations of many of our large industrial corporations, and the generation of young men who are just now taking their places in industrial life are bound to witness the most rapid developments yet realized along this line. It is the ambition of the Institute of Technology to so train her sons that they shall be leaders and worthy workers in this movement.

Our course in Organic Chemistry for Chemists and Chemical Engineers begins in the second term of the third year and continues for two terms. During this time, the student attends an extended course of lectures upon the principles of the science, and receives practice in laboratory work of a varied character. In the latter it is the special aim of the instructing force to keep closely in touch with the individual student, and to help him in the application of theory to practice, and in obtaining the widest possible scientific outlook from the immediate work he happens to have in hand; never allowing the latter to become a matter of mere routine manipulation. The work done in the identification of organic compounds gives valuable training in applying ingenuity to the solution of minor problems in Organic Chemistry. A larger opportunity in the same direction is, of course, afforded to those who elect theses in the subject, while ample facilities are placed at the disposal of those who desire to undertake extensive investigations after graduation.

OBJECT OF COURSE X

Chemical Engineering Making Rapid Advance

By KARL BURROUGHS,
Supt. Fort Hill Chemical Co.

The object of this course is clearly stated in the catalogue and graduates expect to engage in those branches of industrial manufacture which either depend upon or involve chemical principles. That is, in addition to those industries engaged solely in the production of chemicals, numerous others such as the manufacture of cement, soap, paper, glass, glue, gas, explosives and abrasives require a knowledge of chemistry at some part at least of the process.

Thus the field for employment offered by the course is chiefly that of industrial manufacture which in a general way is not so broad as that afforded by some of the older engineering courses. A mechanical engineer has the entire field of manufacture; a mining engineer has only mining enterprises to be sure but they seem liable to involve about everything from railroad construction to commercial manufacturing; an electrical engineer has some lines of manufacture and also the numerous public utilities. As compared with these branches, chemical engineering is much less developed and on the whole this is true of the industries to which it pertains, as far as this country is concerned. It will be found that there are comparatively few such engineers in consulting practice, which I think is due partly to the difficulty in acquiring the requisite practical information and to the fact that demand for such services is small. In fact, owing to varied conditions, and a common lack of knowledge, applicable to such industries, they are more prone to depend upon technical men who have been developed directly in their service. Hence the graduate usually begins work as an apprentice, or aids on some line of commercial research or perhaps in the laboratory or drafting room.

At the start some such work is necessary no matter what particular branch of the profession one ultimately desires to follow, i. e., commercial manufacture or consulting work. That is, some knowledge of practical affairs must be had and also opportunity for developing a sound judgment in such matters.

These industries are to some extent susceptible of division into two classes, viz., those which have developed on so broad a scale that they have but little in the way of secret processes and those which are the results of the development of inventions, where the practical details are either secret or but meagrely known.

The former class comprises those, where owing to demand for their products, manufacture has been extensively undertaken—cement, gas and paper for instance. Owing to the highly advanced stage such industries have reached, apprenticeship is the best route for a technical man to enter them if he desires to master the business. Take the manufacture of paper for example—the product is the result of an extended series of mechanical operations and a thorough grasp of its essentials is not to be acquired by cursory inspections or a casual knowledge of the principles involved.

The second class of industry will only offer a general apprenticeship in exceptional cases. Most technical men enter such industries either in the laboratory or some line of commercial research. The laboratory is the better place to begin, as it affords one some opportunity to observe the operations in actual practice. Experimental or research work as a starter usually means some labor lost before a full realization of practical details is acquired but the work is interesting, especially for those who have the ability to actually do things themselves.

The future of this field is difficult to predict beyond the fact that it is growing. Thus in the past decade it has seen great expansion along such lines as the manufacture of cement and electro-chemical products. The former has about spent its force, while the latter is still due for some further expansion. Growth may also be anticipated to a somewhat limited extent throughout all these industries as the demands become greater.

This course deals with a branch of engineering whose problems are extremely varied and largely undeveloped, hence I do not think it advisable to adopt the course with a view of attempting to specialize. The course is now well adapted for its purpose, viz., the laying of a foundation for acquiring and using a great breadth of scientific knowledge applicable chiefly to chemical problems of an industrial nature.

TECHNICAL ANALYSIS

Examination Of Substances Manufactured Every Day

By DR. A. H. GILL.

This covers an unfamiliar field. Most of us understand the meaning of the terms qualitative and quantitative analysis when applied either to the inorganic or organic world, but have no idea of the subject matter of this article. It deals with the manufacture and analysis of certain substances which are not included in the ordinary analytical chemical course: these are Asphalt, Celluloid, Glue, Inks, Paper, Soaps, Tanning Materials and Leather, Varnishes, Rubber, Boiler Water, Alkaloids. Strangely enough the mere analysis of these compounds is not the chief object sought.

The aim of the course is to encourage individual thinking and foster the spirit of research. While the mere analytical chemist is a necessity—as is the day laborer—yet he is not the highest type. Men with initiative are wanted much more than those with analytical skill; incidentally a knowledge of some new or additional analytical method is of course acquired.

The student is asked to imagine himself graduated and, for example, in a steel works laboratory, making the usual routine analyses; his superior brings him in a sample of rubber upon which he wishes a report as to its availability and value. The subject is read up in some general work as Thorp's "Outlines of Industrial Chemistry" and in the special treatises. The latest numbers of such periodicals as "Chemical abstracts" or the "Chemisches Zentralblatt," "J. Soc. Chem. Industry," etc. are consulted for articles bearing upon the subject in hand. Notes are to be taken upon what is read so that an intelligent talk or paper occupying fifteen or twenty minutes can be presented in the class room; this is expressed in accordance with the principles learned in the study of English, and should be concise but fairly comprehensive. This paper is to be handed in and is kept among the records of the laboratory. The other students are required to take notes upon these talks and the class room exercise is often preceded by a quiz upon the earlier papers. For the laboratory work careful working abstracts of the method to be pursued are made in the laboratory notebook; but before these methods are put in practice a consultation should be had with the instructor as to the best method of procedure. Particular stress is laid upon the keeping of the laboratory notebook as a very important adjunct of research work.

Oils and Gas Analysis.

Besides the work just detailed instruction is given in this same laboratory in the anlaysis of oil and gases. In the former course the usual tests are applied to the various oils to determine their safety and availability for the purposes for which they were intended and also for the identification of the oils. Courses in the analysis of fuel, illuminating and chimney gases, with a discussion of the application that these analyses have upon the economy of manufacturing operations, are given to the students in Courses V., X., XIV., II., VI., and XIII.

PROFESSIONAL ASPECT

Field Practically Unlimited---Importance Of Chemistry

When Hamlet suggested "Why may not imagination trace the noble dust of Alexander, 'til he find it stopping a bung hole?" Horatio thought this strain on his imagination too severe; his intellect could not conceive of so wonderful a transformation. Were Shakespere to write today, however, he would need but a very superficial knowledge of the triumphs of modern chemistry to recognize that Hamlet's was but a very simple proposition. The popular magazines in recent years have done so much to exploit the achievements of chemistry and its influence upon our modern life, that it is but necessary to refer to current literature, for example last week's Saturday Evening Post or Munsey's Magazine for March, to realize the marvellous changes which chemistry has wrought.

An artisan is limited in his work by the tools at his command; an architect by the building materials available; what are the restrictions of the chemist? Clearly he is limited only by the reagents which will submit themselves to chemical change or interaction. But with the exception of argon, neon, and one or two other rare elements, all the materials of the universe are capable of chemical reaction, and all are available for his work. From this point of view the field of the chemist is unlimited, and one need but consider the advance made in the last twenty-five years, to predict the progress of the future.

The man who carried on industrial processes based upon these chemical reactions has always been an important member of the community. Even in the most primitive conditions of society the men who smelted the iron and tanned the leather, dyed the fabrics and burned the pottery, were those who contributed the necessities as well as the comforts to the race. These men were industrial chemists in the sense that they knew the properties of certain raw materials, and the changes which they were able to bring about in them by the agencies at their command. But so long as these industrial processes remained purely empyrical, progress was excessively slow and the different industries benefitted each other but little. With the development of the fundamental principles underlying all chemical change and the establishment of the elementary laws of chemical science, all these industries were found to rest on a common basis, and in proportion as the theory of a process became understood its utility and efficiency increased.

The phenomenal rapidity with which the science of chemistry has developed in the last fifty years, and the progress with which chemical investigations are still being carried on, makes the profession based on chemistry of increasing importance to the community.

The two Institute courses founded upon chemistry, namely Course V and Course X, are differentiated in that the former, after laying a substantial foundation in the fundamental principles of chemistry, allows the student the privilege of moderate specialization in certain particular fields of chemical work, while the latter, also furnishing an equally good foundation in chemistry, devotes an equivalent portion of the time to the principles of mechanical and electrical engineering. The options of the course in chemistry permit of following lines which lead naturally to first, the profession of a teacher of chemistry, or a research worker in chemistry. Much has been said lately about the inadequate salaries paid to teachers; but teachers of chemistry are not unknown to us whose salaries are larger than those of their technical brethren. For the adequately trained research chemist this is an ever-increasing field for employment. While ten years ago there was not, to our knowledge, a single research laboratory in the United States, now there are, exclusive of the research department of educational institutions, eight and possibly more, large manufacturing firms which support well-organized laboratories devoted exclusively to chemical research.

The second option equips more especially for general analytical work. While it is true that what may be called the "pure chemistry" of the early times, namely alchemy, was largely given to fraud of one kind or another, the graduates of Option Two are especially equipped for detecting and combating fraud. The openings in federal, state, and municipal laboratories for the control of foods and drugs are multiplying rapidly, and it will not be long before commercial products other than foods and drugs will be subjected to government inspection and control. The rapidly growing practice for manufacturing organizations to buy and sell upon specification is also calling for men of this general training.

The third series of optional studies of Course V. include bacteriology together with other courses dealing with the problems of sanitation and the public health. The general awakening apparent throughout the entire country and the interest now taken in questions of pure air and water supplies, the disposal of garbage and sewage, the pollution of streams by manufacturing wastes, and similar topics, increase the already large demands for men with the equipment furnished by this option.

The course in Chemical Engineering is essentially the preparation for the man who would apply his knowledge of chemistry to the manufacturing industries. But in order to manufacture economically on a large scale, as complete a knowledge as is possible of mechanical engineering is necessary. With this end in view, in addition to offering a thorough training in chemistry, fundamental courses in drawing, mechanism, applied mechanics, steam engineering, elementary electric engineering, etc., are introduced. Such a course should equip a man not only to originate ideas relating to the application of chemistry, but should enable him also to carry these ideas into effect. In a manufacturing business based upon chemical changes he is able not only to diagnose the ills of the patient, but to prescribe a remedy, and to operate if necessary.

There was a period in our industrial development when "increased production" was the watchword of the day. Our unsurpassed wealth of raw materials made it possible to operate at a profit in the face of the most extravagant wastefulness. But evidence is everywhere at hand that a change has come over the manufacturing public, and while we still strive for increased production, more attention is constantly being paid to increased efficiency of production. In the industrial progress of the future, the chemical engineer will play an important part. From the Research Laboratory, where his composite chemical-engineering training makes him particularly valuable, to the details of factory design, equipment and operation, the chemical engineer will be more and more an indispensable factor in determining the prosperity of the country, and the comfort and material well-being of its inhabitants.

WATER ANALYSIS

By MRS. E. H. RICHARDS.

Of all the varied problems brought to the chemical laboratory for solution none has had more perplexing history than that of deciding on the quality of water for different uses. No technical subject ever had a hotter warfare over methods than was waged between 1860 and 1880 over the determination of organic matter and its significance in water. The earliest investigations in America in these directions were made for the Mass. State Board of Health in improvised laboratories in the basement of Rogers Building, 1872-1875, when the foundations for subsequent methods in general use were laid.

In 1884 a course in sanitary chemistry to include water analysis was established at the Institute. It was, as so much of the Institute work has been, in response to the demand, coming from those in the field, for more work than they had received. In the twenty-six years the laboratory notes have been rewritten fourteen times, in the attempt to keep up to date. The positions which former students hold in the world of Sanitation, as well as their statements in regard to the course seem to offer abundant proof of the success of this attempt.

In line with this policy of keeping up with the times, the laboratory has recently been rearranged and refitted in accordance with the most modern practice.

Four courses come to the laboratory for the various branches of water analysis; Courses V. and VII. take up only sanitary analysis. Their work is really more of an educational than of a technical nature. Course V., fourth year, learns the necessity of the application of refined methods to the determination of small quantities and how to handle apparatus without contaminating it. They are also trained in the use of color reactions for the determination of very minute amounts of the various impurities occurring in water.

The students get an outlook into the great field of chemical operation through another door. They put in practice all the manipulation they have learned in preliminary courses.

Course VII., third year, receives a similar training but with a leaning towards those methods and operations which are the result of, or accompany, bacterial action, the work being a link in the chain of the correlated sciences.

Students of Course X. who follow their profession will have very serious problems to face—becoming more serious each year—relating to quality of water for manufacturing purposes, and especially to the effects on boilers and pipes. They must be prepared to watch the new conditions imposed by treated waters and the subsequent use of these waters for irrigation, etc.

For these students a short course as an eye-opener is given in the fourth year. Three or more samples from different sections of the country are examined for their principal characteristics. This examination then forms the basis of judgment as to what industries the water is suited, or to what it may be suited by treatment. References are given and discussed concerning the subjects to watch for in current literature. A compact little laboratory manual has been prepared covering the needed work in industrial water analysis as it can be given in a half school year.

In the third year, Course XI. uses this same manual for a somewhat similar though more complete course in industrial water analysis.

In the fourth year the laboratory gives Course XI. a very complete course in water analysis and water supplies. This work while chemical in nature is approached from an engineering standpoint.

The great aim of the laboratory in all the courses is to present such problems as may be met with in actual practice and in this way to present to the student a professional point of view.

CHEMICAL SOCIETY

Popular With Students And Members Of Department

The chemical society organized in 1903 has ever been successful in its attempt to further the interests and broaden the point of view of its members.

Although having a considerably smaller membership than many of the professional societies, the meetings are well attended. Students who are taking chemistry in the second, third, and fourth years are eligible for membership, and the annual dues are fifty cents.

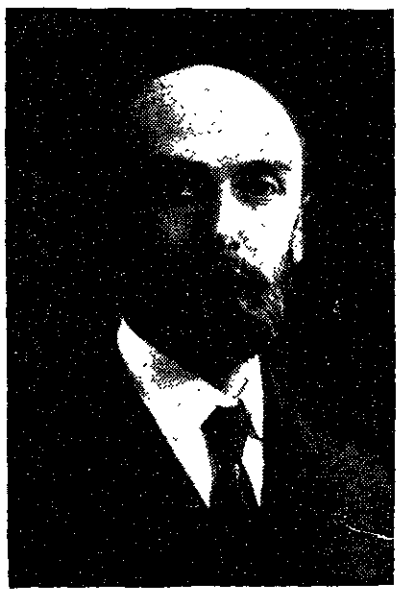
The chemical faculty have always shown a keen interest in the affairs of the society, evidenced not only by their attendance at the meetings and dinners, but also by their willingness to present subjects in which they have specialized and which are of great practical benefit to the students.

During the year at least one banquet is held, and each month one or more men, prominent in some special branch of work, presents a topic of general interest. As is true of all similar societies at the Institute, greater interest by the members will give greater satisfaction in that it will stimulate the officers to greater activity and warrant holding meetings more often than is now practicable.

INORGANIC CHEMISTRY

By HENRY P. TALBOT.

The instructional problem presented by the subject and its position in the curriculum is not an easy one to solve. Provision must be made for students with a little knowledge of chemistry (often dangerous), others with no previous experience, and still others with considerable previous training in secondary schools. Moreover, provision must be made on the one hand for the chemist, and mining or chemical engineer to whom chemistry is a professional subject, and for the civil engineer and mechanical engineer to whom chemistry is not an unalloyed joy. And to all this is added perhaps the most important task of all, the induction of these students into proper scientific methods of observation and reasoning. A subdivision of the class based upon previous experience in chemistry (or its lack)



PROF. H. P. TALBOT.

in the first term, and in the second term upon prospective choice of chemical subjects in later years, has simplified the task somewhat and increased instructional efficiency.

The instruction comprises, first, lectures, in which are discussed the important principles and the salient facts chosen with reference to the application of these principles and to their practical importance; second, recitations which are regarded as the students' opportunity to clear up his uncertainties, and for this every encouragement is given; and third, the laboratory exercises, which are regarded as perhaps the most important phase of the course. Here the student is encouraged to try to reason from observations, necessarily under considerable guidance at first, and always under such direction as to try to avoid groping and the drawing of wild conclusions. Greater stress is laid upon a relatively small amount of careful work than a wider range of experimentation of an essentially descriptive character, in order to attempt to lay a firmer foundation for later study whether in chemistry or along other lines. The careful and intelligent recording of observations, a matter which is always difficult of accomplishment at first, receives its due share of attention.

In the second half of the year the laboratory work takes the character of synthetic inorganic chemistry, to illustrate the chemistry of typical compounds, for those who will continue with chemical subjects, while the engineering students in non-chemical courses have laboratory practice in qualitative analysis, and some other laboratory work especially adapted to their needs.

The recitation and laboratory instruction is in charge of Professors T. E. Pope, F. L. Bardwell, A. A. Blanchard, Mr. J. W. Phelan, and Drs. E. B Spear and S. Jordan. The lectures are given by Professor H. P. Talbot.

HISTORY OF COURSE

(Continued from page 41.)

a wide experience in Industrial Chemistry and Metallurgy, and was made Professor of these branches of instruction, holding that position until 1885. In 1870 we find Professor R. H. Richards temporarily serving as Assistant Professor of Analytical Chemistry and Professor William Ripley Nichols, to whom the Department owes so much for his successful labors in Sanitary Chemistry, as well as the gift of his library, entering the Faculty as Assistant Professor of General Chemistry. In 1871 Professor James M. Crafts took Professor Warren's place in Organic Chemistry coming fresh from the field of research, and gave an added impetus to the Department.

In 1873 the differentiation between the various professional courses began at the opening of the second year and the Course in Chemistry was somewhat remodeled, and more time was given to chemistry in the second year. In 1873 Professor Charles H. Wing became a member of the staff and did much to place analytical chemistry on a more refined basis. In 1878 the Women's Educational Association of Boston endowed the Women's Laboratory, which was then located in a one-story structure occupying the space now vacant between the Rogers and Walker Buildings. In this laboratory Mrs. Ellen H. Richards was instructor in chemistry and mineralogy and in association with Professors Ordway and Nichols carried on an immense amount of analytical and experimental work along lines of sanitary and industrial chemistry which later formed the foundation for the development of these branches in our Chemical Department. In the same year three options, one in mathematics, one in natural sciences and one in industrial chemistry were offered within the chemical course.

The transfer of the Chemical Department to the Walker Building in 1883 placed it in temporarily commodious quarters and made possible a general development. Professor Lewis M. Norton then took charge of the Organic Chemistry and later of the Industrial Chemistry, and to him much credit is due for the development of these branches, and for inspiring teaching.

In 1885 Professor Thomas M. Drown became Professor of Analytical Chemistry and was soon placed in charge of the Department. He, in association with Mrs. Richards, developed the work in Sanitary Chemistry and during the next few years instituted and developed the elaborate system of examination of the water supplies of the State which was unique in its extent and thoroughness and has served as a model for all later work along these lines in this and other states. Over 20,000 samples of water were examined and reported upon in the Institute laboratory, making it the leader of its sort, and after the work was removed to the State House, Dr. Drown remained until his death consulting chemist to the State Board of Health. Dr. Drown was also instrumental in gradually introducing a greater variety of specialized and optional subjects into the Chemical Course.

In 1888, as a result of a demand for a course which should combine chemistry with engineering, and after conferences of Professors Norton and Drown and the members of the Department of Mechanical Engineering, a Course of Chemical Engineering was announced which was under the charge of Professor Norton. This course was mainly one of mechanical engineering with a limited amout of fundamental chemical instruction. On the death of Dr. Norton in 1893 the Course passed to the care of Dr. Drown and was united with the Department of Chemistry. For some time after the resignation of Dr. Drown to accept the presidency of Lehigh University, the Department remained without an officially appointed head. During that time the course in Chemical Engineering changed but little and the main change or note in the Chemical Course was the introduction in 1900 of five series of consistently arranged optional studies, of which three remain at present, one series involving mechanical engineering subjects having been abandoned when the Chemical Engineering Course was modified, and one in Metallurgy proving to be impracticable. In 1901 the Department was placed in charge of Professor H. P. Talbot.

After a careful consideration of the demands made upon the graduates entering the field of applied chemistry, as chemical engineers, it was determined in 1905 to remodel the Course in Chemical Engineering and to give it its present form, that of a course which is mainly one of chemistry with as much fundamental engineering as the time permits, the proportion of time devoted to chemistry being almost twice that devoted to engineering. Since then the course has undergone only minor changes.

Meanwhile the work of the Department has grown rapidly. Its originally commodious quarters have been many times extended, with the result already stated. In 1903, through the generosity of Professor A. A. Noyes, the Research Laboratory of Physical Chemistry was established, which, though not a part of the Departmental organization, has afforded exceptional opportunities for the work of advanced students. Still more recently, 1908, the Research Laboratory of Applied Chemistry was organized as a branch of the Department under the Directorship of Professor W. H. Walker.

The staff of instruction comprises thirty-three members exclusive of the research workers and is providing instruction for nearly a thousand students yearly, and the business transactions of the Department, which are under the immediate charge of Professor A. H. Gill, amount to about $15,000 annually.

With an unusually loyal and capable instructing staff, a large number of successful graduates, and a demand for others much in excess of the present supply, together with an increasing appreciation in the country at large of what the chemist and chemical engineer can accomplish, and an increasing interest on the part of our students in chemical engineering, the opportunities and outlook for the future of the Department seem unusually bright.

FIELD OF CHEMISTRY

(Continued from page 45.)

When I was a Freshman at Tech, I chose Chemistry as a profession because I liked it. I did not like the financial outlook, but I was incapable of judging it. I was fearful lest I should fail to make good. If I were suddenly to find myself again a freshman at Tech, I would again follow Chemistry. By my inability to do more than keep up with the requirements of the course, I should regret not being able to acquire simultaneously a broader knowledge, but that is all. I cannot recall any considerable part of my work in the chemical course which I should be willing to exchange for its time-equivalent in more general college studies. I am enjoying some of these general pleasures now, probably, more than I should, had I been forced to study them earlier. I should look forward more to acquiring proper habits of thinking and doing than to storing up the detailed knowledge set before me, however interesting it was to the teacher.

I should want to feel early that I was making the realm of Chemistry my personal property in which others could

(Continued on page 43.)